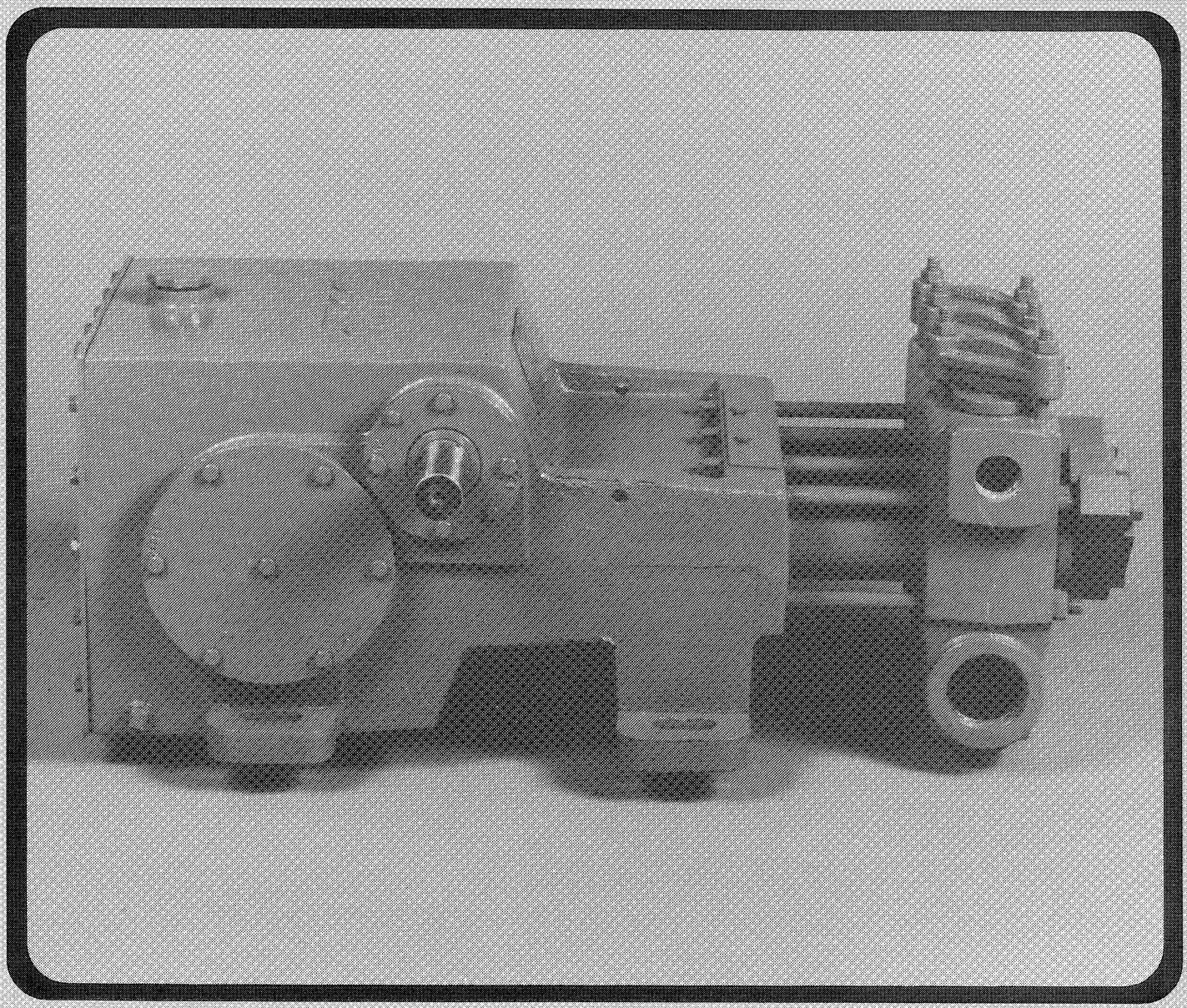
FMC

Manual No.
3267689

# Owners Manual

## Industrial Pump
## Model L16



# Safety Instructions

Accidents occur every year because of careless use of industrial equipment. You can avoid hazards involved with high pressure pumping operations by following these safety instructions.

## ⚠ WARNING

**Always use a pressure gauge when operating pump.** The pressure must not exceed specified rating of the pump or pump could be damaged causing leakage, resulting in injury to personnel in vicinity.

**Do not adapt relief valves to maintain more pressure than their specifications state.** This could result in relief valve or pump casing bursting due to too much pressure. Personnel in general area could be physically harmed.

**Do not put a valve between the pump and relief valve.** If the pump should be started with this valve closed, this could put excessive pressure on the pump which could cause the pump case to burst and might injure personnel or other equipment in vicinity.

**Be sure to use shields or covers on pumps used for pumping hot water or chemicals.** This precaution can prevent service personnel from being burned by hot water or exposed to chemicals when leaks might occur.

**Be sure to use shields or covers on all sheaves, belts and drives.** Guards can prevent personnel from becoming seriously injured by being entangled in fast rotating parts.

**Always disconnect the pump from the power source before performing any service to the pump.** Failure to do this could cause electrical shock or injury from moving pump parts.

**Always relieve pressure on the system before performing fluid end maintenance.** Failure to do so may spray water or chemicals on service personnel causing water burns or chemical exposure.

**Use extreme care when using solvents to clean pump and pump parts.** Most solvents are highly flammable. Observe all safety instructions on packaging. Fires could result in serious burns to personnel and serious damage to equipment.

**Do not modify the pump to function beyond its specifications.**

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**To Our Customers:**

We at FMC would like to express our appreciation in your decision to use one of our industrial pumps. This pump was designed by experienced engineers and built by skilled workmen to provide you with quality equipment.

FMC stands behind all its products. The warranty on your pump is printed on the back of the Delivery report. Be sure your dealer has you sign a Delivery Report and supplies you with a copy.

# SECTION A
# Installation Procedures

### Storing Before Installation

Your FMC pump will come to you prepared for indoor and short-term outdoor storage. For long-term storage, contact your sales representative or factory for instructions.

### Selecting Pump Location

Always locate the pump as close to the source of supply as possible. The pump should also be located in a light, clean, dry space where adequate inspection and maintenance operations can be performed.

### Securing Pump to Foundation

| STEPS | PROCEDURES |
|---|---|
| 1 | Locate the pump so the power will turn the top of the pump pinion shaft away from the fluid end of the pump. L16 pumps have only a single shaft extension, therefore, it is important to specify RH or LH drive to match the power source and drive system arrangement. |
| | **NOTE: Fluid can be pumped satisfactorily regardless of the direction of rotation. However, friction and wear on internal components will be reduced by using the recommended rotation.** |
| 2 | Mount the pump on either a concrete or rigid metal base using the mounting supplied with the pump and 3/4" bolts. (Use shims to level the pump, if necessary, to prevent straining the pump case.) |
| | **NOTE: Proper alignment of the drive sheaves is very important to prevent excessive pump bearing and drive component wear.** |
| 3 | If the pump is V-belt driven, check the alignment of the sheaves after the unit is installed on its permanent mounting. Tighten belts to proper tension. Place a straight edge against the sides of the sheaves to be sure they are in line and running exactly parallel to each other. Replace all guards. |
| 4 | If the pump is direct coupled through a gear reducer, check the alignment of the shafts after the unit is installed on its permanent mounting. Reassemble and lubricate the couplings if they have been removed. Replace all couplings and shaft guards. |

## Installing the Pump Suction Line

| STEPS | PROCEDURES |
|---|---|
| 1 | Determine the shortest most direct route possible for the suction line. |
| 2 | Make a preliminary design of suction piping. Remember, the line should be as large, direct and short as possible. The suction manifold should be a minimum of one (1) pipe size larger that the pump inlet. Use an eccentric reducer (straight side on top) to reduce near the pump. |

**NOTE: The line must be laid out so there are no high spots to cause air pockets. Any air pockets in the line could make priming the pump difficult or impossible.**

| | |
|---|---|
| 3 | Analyze the Net Positive Suction Head that would be available in your preliminary design. The Net Positive Suction Head Available (NPSHA) is a characteristic of your pumping system determined by:<br>a. The elevation of the suction supply in relation to the pump suction port (static head). |

**NOTE: Static head is plus (+) when liquid is above the pump's center line, and minus (-) when liquid is below (or suction lift).**

b. Altitude of the installation above sea level (atmospheric head).
c. Friction in suction line (friction loss).
d. Liquid vapor pressure (VP).
e. Amount of suction head required to accelerate fluid in the suction pipe to prevent cavitation (acceleration head).

**NOTE: NPSH = ± static head + atmos. head-friction loss-acceleration head-VP**

| | |
|---|---|
| 4 | Compare available NPSH with required NPSH for your pump at your particular RPM requirements. |

**NOTE: There must be at least two additional feet of NPSHA over the required NPSH to compensate for variations in atmospheric pressure and other similar variables.**

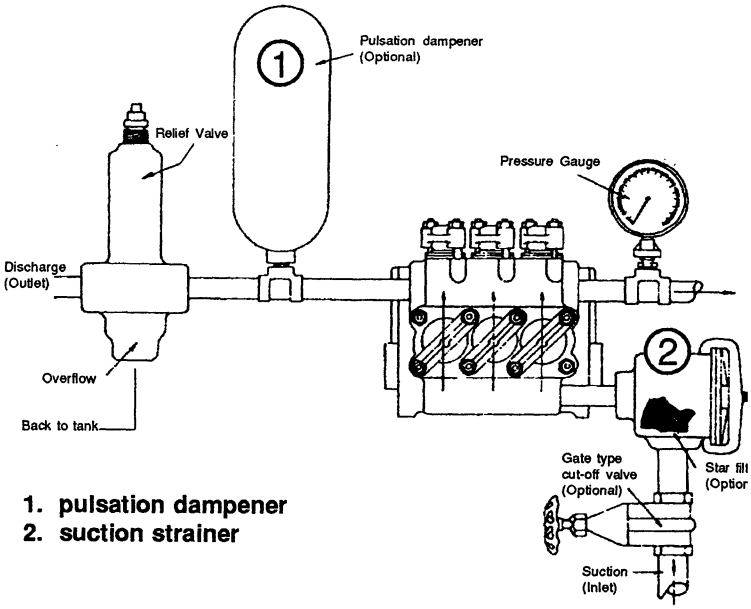
| | |
|---|---|
| 5 | After determining the correct suction line for your required needs, install the line. The suction line should be supported independently of the pump. Install a union as close to the pump as possible, to allow for easy removal of the fluid cylinder during servicing. |

**NOTE: It is advisable to use a flexible connection such as a hose between the hard pipe and pump suction opening to isolate vibrations.**

**NOTE: Be sure all parts are free of dirt, scale, burrs, or other foreign material which might interfere with pump operation.**

## Installing the Pump Suction Line - Con't.

| STEPS | PROCEDURES |
|---|---|
| 6 | Install a foot valve when there is suction lift. The foot valve should be installed in the suction line near the fluid source. The foot valve will keep the lines to the pump filled and avoid the necessity of priming at each start. |
| 7 | If required to compensate for acceleration head losses, install a properly sized suction stabilizer near the pump inlet. |
| 8 | Install drain plugs or drain cocks in low points of suction lines. |
| | **NOTE: This is highly important where temperature conditions are below freezing.** |
| 9 | Install suction strainer [2] in the suction line to remove particles that could damage internal pump components. |
| | **NOTE: Use only full opening gate valves or ball valves for minimizing flow restriction.** |
| 10 | Make sure all joints are air tight. |
| | **NOTE: Air leaks reduce pump capacity and cause cavitation.** |

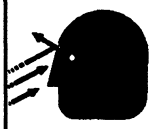



**1. pulsation dampener**
**2. suction strainer**

## Installing Pump Discharge Lines

| STEPS | PROCEDURES |
|---|---|
| 1 | Determine the shortest, most direct route for the discharge line. |
| 2 | Determine the length of hose or pipe required and determine the size of the hose or pipe by considering pressure loss per foot of hose required. |
| 3 | Select weight of pipe required to meet pressure requirements from adjacent chart. Hose ratings are clearly marked on outer surface of hose. |

**WARNING**



**Always use hose or pipe that is designed for your particular pressure requirements. Inadequate hose could burst resulting in possible personal injuries and equipment damage.**

| | |
|---|---|
| 4 | Install pipe or hose to pump. |

**NOTE: Be sure all parts are free of dirt, scale, burrs, or other foreign material which might interfere with pump operation.**

| | |
|---|---|
| 5 | Install the pressure gauge [1] onto the discharge line. A properly rated and maintained gauge is essential to the safe operation and maintenance of the pump. |
| 6 | Install a relief valve [2] or rupture disc onto the discharge manifold as a safety device. If the fluid is drawn from a tank, the relief valve by-pass should be returned to the tank. The flow may be returned to the suction line (when other means of return are not possible) if it is returned into the line as far as possible from the pump to reduce the possibility of turbulence and cavitation in the suction line. |

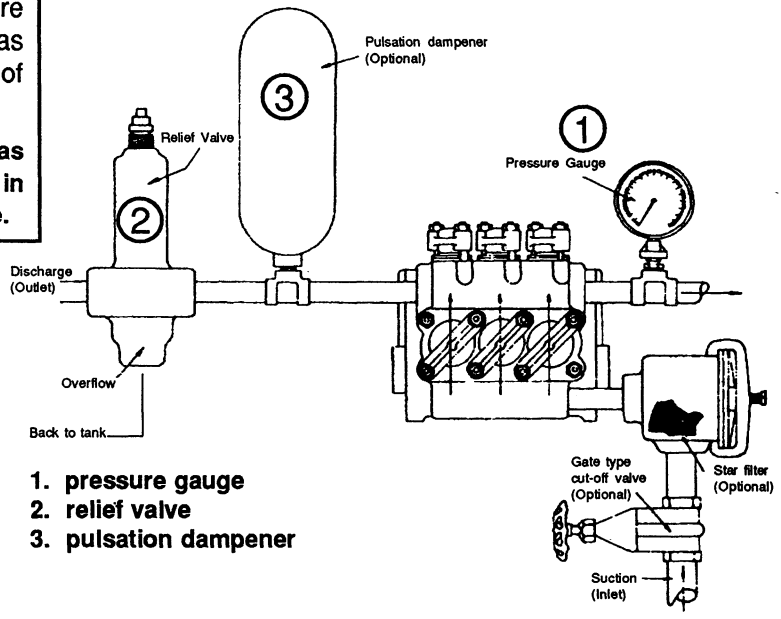
**NOTE: The relief valve by-pass line must be as large as the pipe outlet in the relief valve. Never install valves in the by-pass line or between the pump and relief valve.**

| STEPS | PROCEDURES |
|---|---|
| **Optional** | |
| 7 | A discharge pulsation dampener may be installed to absorb pulsations, pounding and prevent water hammer. It should be installed very near the pump. Bladder type pulsation dampeners should be pre-chartered to approximately 2/3 of the maximum anticipated pump pressure. |

## Pipe pressure chart

Pounds per square inch
For cold water, minor shock conditions
**Working Pressures**

| | Seamless Steel Pipe ASTM A120 | | | | Butt Welded Pipe ASTM A120 | | | |
|---|---|---|---|---|---|---|---|---|
| Pipe Size | Std. Wt. Sch 40 | Extra Heavy Sch 160 | Heavy | Double Extra | Std. Wt. Sch 80 | Extra Heavy Sch 160 | Heavy | Double Extra |
| 1/2 | 1650 | 3000 | 4500 | 8480 | 1000 | 1800 | 2700 | 5100 |
| 3/4 | 1370 | 2460 | 4300 | 6980 | 820 | 1480 | 2590 | 4200 |
| 1 | 1220 | 2190 | 3780 | 6340 | 730 | 1320 | 2280 | 3818 |
| 1 1/4 | 1040 | 1850 | 2850 | 5230 | 630 | 1120 | 1720 | 3148 |
| 1 1/2 | 900 | 1650 | 2830 | 4680 | 540 | 990 | 1700 | 2800 |
| 2 | 800 | 1480 | 2900 | 4030 | 480 | 890 | 1750 | 2430 |
| 2 1/2 | 800 | 1450 | 2380 | 4160 | 480 | 870 | 1430 | 2500 |

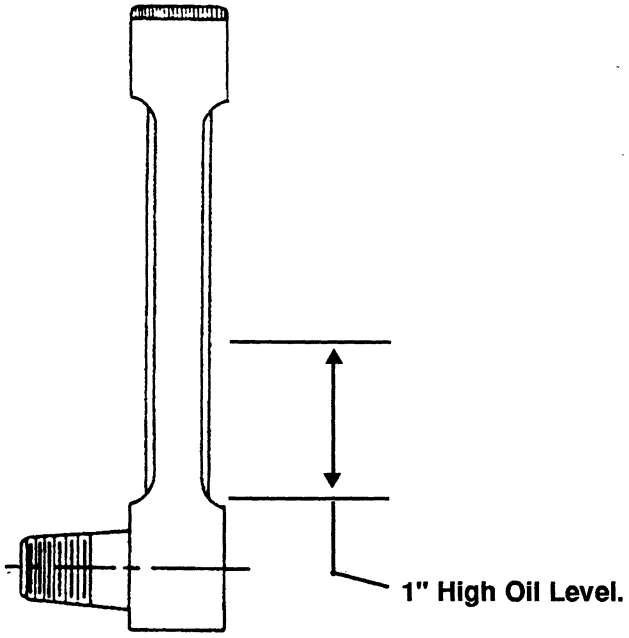


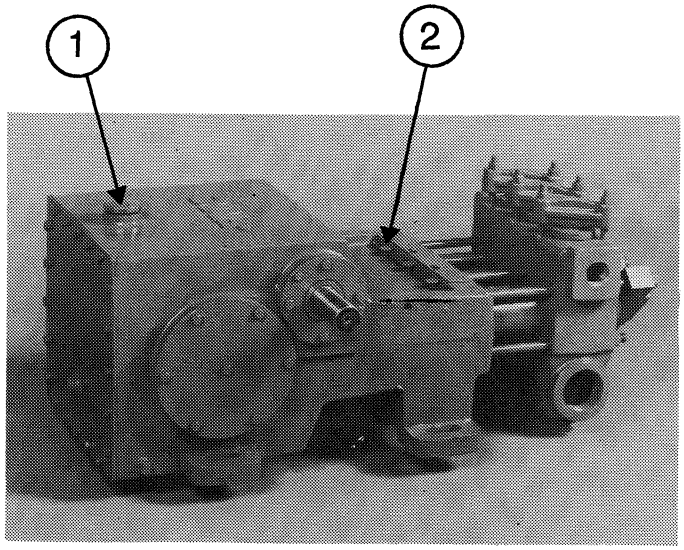

1. **pressure gauge**
2. **relief valve**
3. **pulsation dampener**

# SECTION B
# Operation

**Checkpoints Before Starting -** Always make the following checks before starting the pump.

| STEPS | PROCEDURES |
|---|---|
| 1 | Make sure the magnetic drain plug in the bottom of the pump case is tight. |
| 2 | Check the oil by means of the sightglass. If necessary, add a good grade of SAE 80W90 non-detergent gear oil through the filler opening [1]. |
| | **NOTE: The oil should come up 1" high in the sightglass on the back of the drive end.** |
| 3 | Inspect the entire pump installation to make sure all the joints are tight. |
| 4 | Apply grease to the 3 grease fittings [2] and regrease every 1,000 hours or twice a year. |
| | **NOTE: Grease with a good grade of water resistant grease.** |

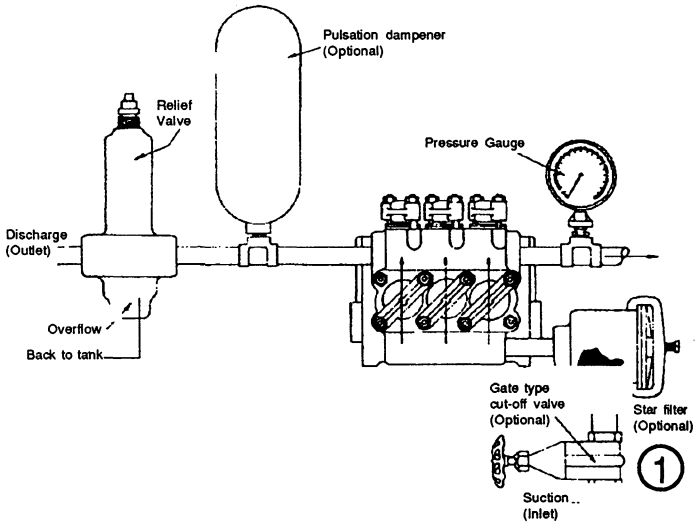



**1. Filler Cap**
**2. Grease Fittings**

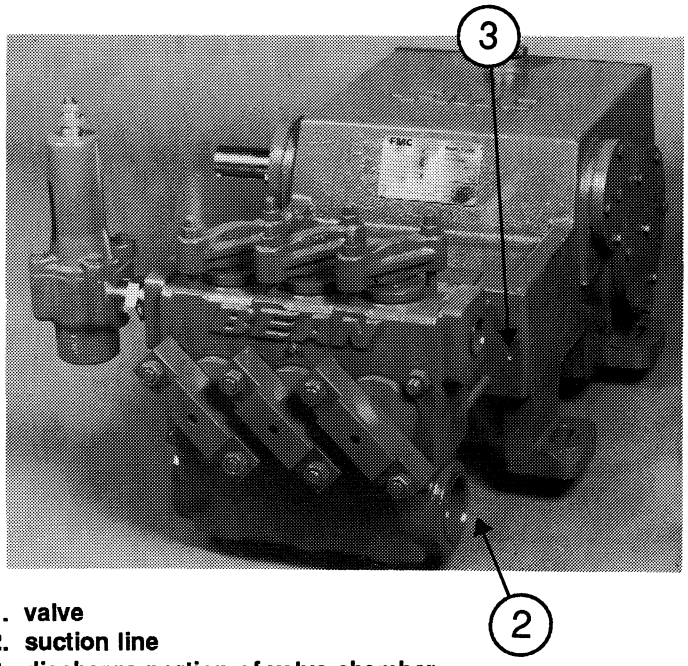
**Starting the Pump -** The following procedures should be followed when starting the pump for operation.

| STEPS | PROCEDURES |
|---|---|
| 1 | Open the valve in the suction line [1]. |
| | **NOTE: The gate valve must remain fully open during operation of the pump.** |
| 2 | Check to assure power is off. |
| 3 | Turn the pump over by hand to make sure the crankshaft is free. |
| | **WARNING** |
| | **Never try to turn the pump over when the power is on. Service personnel could be entangled in moving sheaves.** |
| 4 | Fill the suction line with fluid, if necessary, to prime pump [2]. |
| 5 | Start the pump, and for a few seconds, listen for erratic noise or for unsteady flow which would indicate the pump is not primed. |
| | **NOTE: Never run the pump over 30 seconds not primed.** |
| | If flow is not continuous (pulsing), shut the pump off and prime. |




**Priming the Pump -** The following procedures should be followed when priming the pump.

| STEPS | PROCEDURES |
|---|---|
| 1 | Fill the suction line and strainer. |
| 2 | Remove the accumulator or the pressure gauge. |
| 3 | Fill the discharge portion of the fluid cylinder with fluid [3]. |
| 4 | Jog the pump until the fluid is pumped from the discharge ports in a steady, even flow. |
| 5 | Reinstall the accumulator or pressure gauge. |
| 6 | Start the pump and listen for unsteady flow or erratic noises. If unsteady flow persists, repeat Steps 1-6 until pump is properly primed. |
| 7 | If pump continues not to prime, check the piston seals to see if there is excessive leakage through the seals. Should the seals be leaking 15 to 20 drops per minute, shut the pump off and replace the seals (refer to Service, Section D). |




1. **valve**
2. **suction line**
3. **discharge portion of valve chamber**

## Shutdown Procedures During Freezing Temperatures

The following procedures should be followed when stopping or storing the pump during freezing weather.

| STEPS | PROCEDURES |
|---|---|
| 1 | Let the pump push air for a few seconds with the discharge outlet and suction line open. This will flush the valves and discharge lines. |

**NOTE: When pumping liquids that cannot be contaminated by using a diesel fuel, pump diesel fuel through the system. By doing this, you will eliminate the need for Steps 2-12.**

**WARNING**

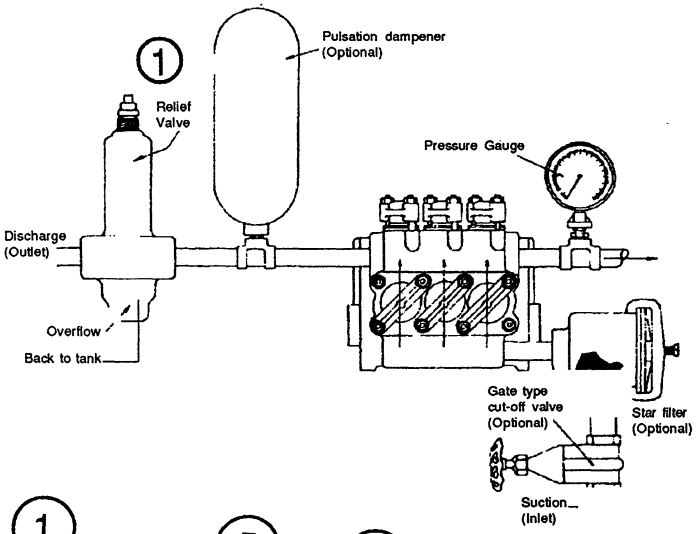
**Do not use this procedure when pumping fluids that can be contaminated by having diesel fuel in the pump or suction and discharge lines.**

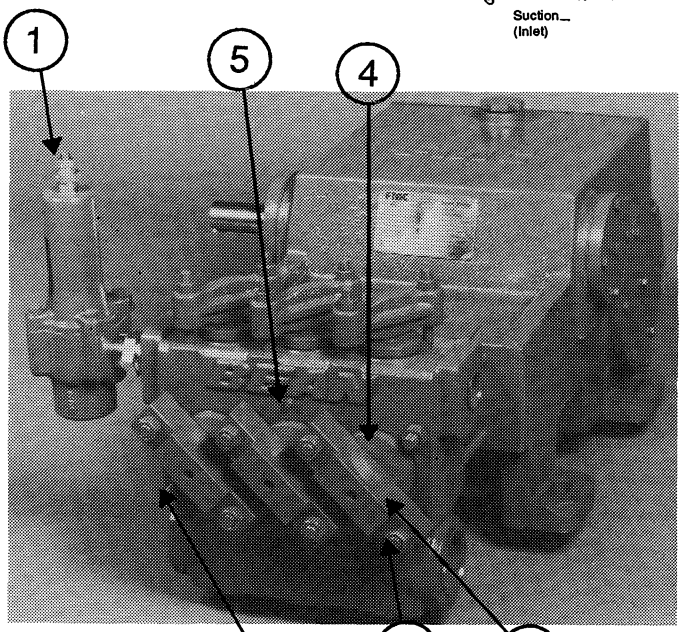
| | |
|---|---|
| 2 | Shut the pump off. |
| 3 | Relieve pressure on the relief valve by turning the adjustment of the valve counterclockwise [1]. |

**WARNING**

**Failure to do this could cause fluid to shoot out when discharge manifold is removed and fluid could possibly splash in operator's eyes.**

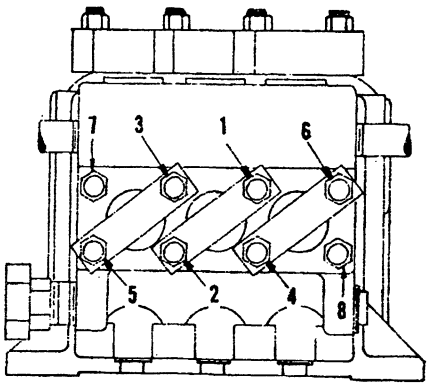
| | |
|---|---|
| 4 | Remove the four 1/8" drain plugs in the fluid cylinder. Also remove plugs in the fluid cylinder. Also remove plugs from under the suction valve area of the fluid cylinder. |




1. **Relief Valve**
2. **Hex Nuts**
3. **Cover Clamps**
4. **Valve Covers**
5. **Drain Plugs**

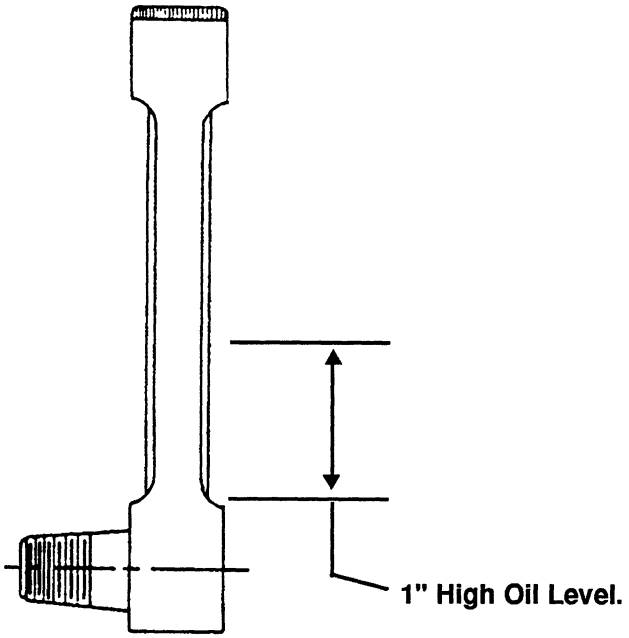
**TIGHTENING SEQUENCE**



**Shutdown Procedures During Freezing Temperatures (Continued)**

| STEPS | PROCEDURES |
|---|---|
| 5 | Remove the six (6) hex nuts and the three (3) clamps from the cylinder chamber. |
| 6 | Slide the cylinder cover from the fluid cylinder. |
| 7 | Drain all trapped fluid from inside the fluid cylinder by lifting the suction valve with the end of a wooden dowel or screwdriver. |
| 8 | Coat the valve cover with a rust preventative agent. |
| 9 | Replace the valve cover clamps and hex head screws. |
| **NOTE: Lubricate bolts before replacing nuts.** | |
| 10 | Torque the hex head nuts in the sequence shown to the specified torque requirement. |
| 11 | Replace drain plugs in fluid cylinder. |
| 12 | Remove drain plugs in all low points of piping. |
| 13 | Leave all cutoffs open. |

# SECTION C
# Maintenance Procedures

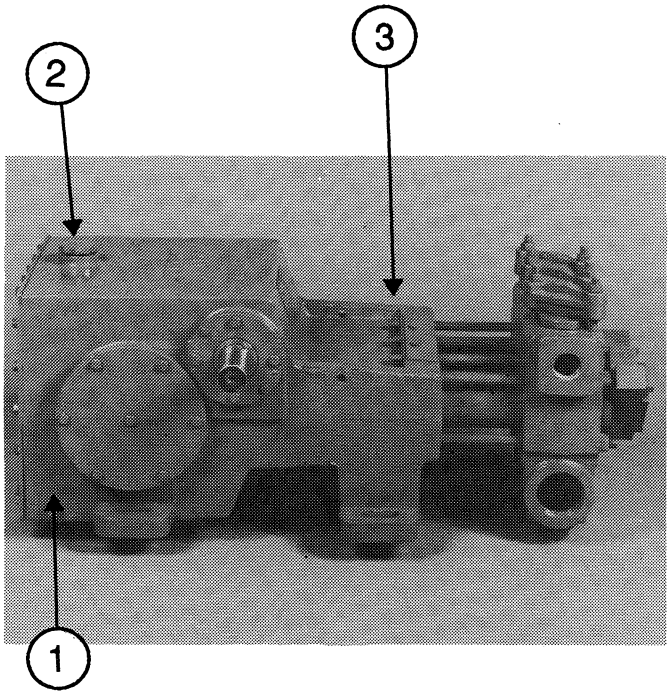



The L16 pumps require ten quarts (9.5 liters) of grade SAE 80W90 lubricant in the crankcase. The oil level will be a little below halfway on the sightglass. After the first fifty hours of operation, drain oil from the crankcase and remove any metal adhering to the magnetic drain plug. Thereafter, at the end of each 2,000 hours of operation, the oil must be drained and the drain plug [1] should be cleaned of any metal adhering to it. Should oil have a milky appearance, this indicates water is leaking past the piston rod seals in the pump. The piston rod seals should be checked and replaced, if necessary. After draining all the oil, replace the drain plug and add the oil through the oil fill opening [2]. Another area of the pump requiring lubrication are the fittings on the piston oil seal holders. These fittings should be greased once yearly [3].

**CAUTION**

**Do not over grease fittings to the plunger oil seal holders or damage could occur to oil seal and holders.**

A strainer should be installed in the suction line to prevent contaminated material from entering the pump and reducing its life and efficiency. During the initial break-in period, the pump strainer screen should be inspected frequently. The amount of material trapped in the strainer during these inspections will indicate how often the strainer screens should be checked. A regular inspection schedule should be developed from this information.



# Periodic Maintenance Chart

| Components | Description of Service | Remarks |
|---|---|---|
| | **Break-in Period** | |
| Crankcase | Drain oil from crankcase by removing plug. Clean any metal adhering to plug before replacing. Refill pump case with new oil. | After the first 50 hours of operation. |
| Pump Strainer Screen | Should be inspected frequently to determine a regular inspection schedule. | The amount of material collected in the strainer with each check will indicate how often the strainer should be inspected. |

| Components | Description of Service | Remarks |
|---|---|---|
| | **Daily** | |
| Complete Pump | General inspection of pump in operation to determine if it is functioning properly. | This inspection should take place once each shift of operation. |
| Piston Rod Oil Seals | Inspect piston rod oil seals for leakage. | Leaking at the rate of one or two drops per minute indicates the need for replacing the oil seals (refer to Servicing the Piston Rod Oil Seals, page D-7). |
| Piston Seals | Inspect piston seals for leakage. | Excessive dripping at this point indicates worn piston seals. Adjust or replace as necessary (refer to Replacing the Piston Seals, page D-3). |
| Pump System | Use water or a suitable solvent and flush the entire system. | For overnight shutdown when using materials that might harden or corrode the pump.<br>Drain all water from pump cylinders and piping when freezing temperatures are anticipated. |
| Crankcase | Check oil level in crankcase at the sightglass on the end of the pump. | With pump stopped, oil level midway up sightglass indicates proper oil level. |
| **NOTE:** Do not over-fill; oil will run out of oil sightglass or be thrown out breather when too full. | | |

## Periodic Maintenance Chart - Con't.

| Components | Description of Service | Remarks |
|---|---|---|
| | Every 2,000 Hours<br>(equals 2.7 months of continuous use) | |
| Crankcase | Change oil and clean magnetic plug. | SAE 80W90 gear oil (non-detergent). |

| Components | Description of Service | Remarks |
|---|---|---|
| | Long Term Storage | |
| Pump System | Drain pump (refer to Shutdown Procedures During Freezing Weather, page B-3). | During freezing temperatures. |

# SECTION D
# Service

In this section, we will cover how to service the pump. The first portion will cover step-by-step procedures for servicing the different areas of the pump. Then, at the end of this section, you will find a quick reference trouble-shooting chart.

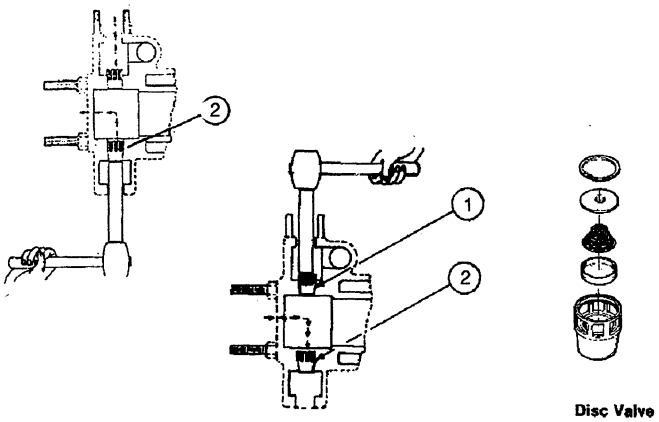
**Servicing the Fluid End**

**Servicing the Valves -** Malfunctioning valves are identified by a uniform hammering or vibration and by reduced pump capacity (volumetric efficiency).

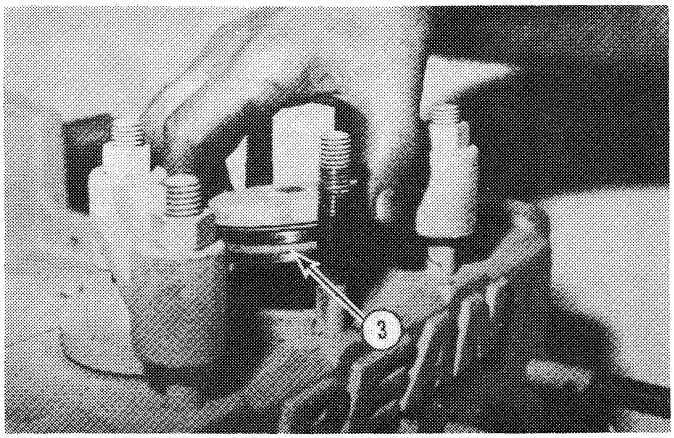
| STEPS | PROCEDURES |
|---|---|
| | **WARNING** |
|  | **Always disconnect pump from power source before performing any service to the pump. Failure to do so could cause electrical shock or injury from moving pump parts.** |
| 1 | Remove all plugs in discharge or suction inlets. |
| 2 | Remove the six (6) nuts on the studs. |
| 3 | Slide the three (3) cover clamps off the studs. |
| 4 | Replace the nuts on the studs. Place bar clamps on the studs. Insert a 3/8-16UNC all-thread with nut through a clamp and into a cylinder cover. Tighten the nut, pulling the cover from the valve housing. Reference Step 4, page D-3 for illustration. |
| 5 | Remove the six (6) nuts on valve cover studs. |
| 6 | Remove valve cover clamps. |
| 7 | Remove valve covers. |
| 8 | Rotate the shaft so one (1) piston is on the complete down stroke. |

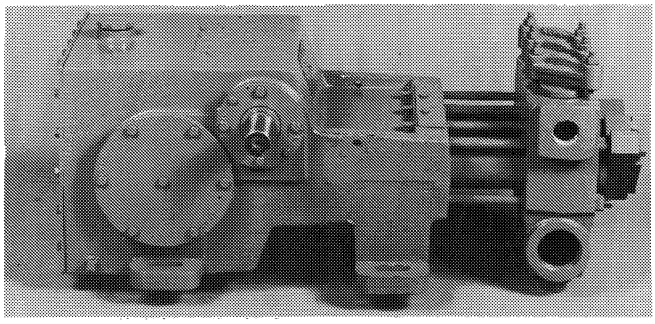
| STEPS | PROCEDURES |
|---|---|
| 9 | Replace the valve seat remover tool (FMC #1285079) or a blunt rod against the suction valve seat and by using a hammer, drive the suction valve seats loose. |
| 10 | Remove all three (3) suction valves in the same manner. |
| 11 | Insert the blunt tool through the opening for the suction valves and position against the discharge vale seat. |
| 12 | Using the hammer, drive the discharge valve out the chamber discharge opening. |
| 13 | Remove the valves through valve cover opening. |
| 14 | Repeat until all discharge valves are removed. |
| | **NOTE: The complete valve assembly is available for easy and quick servicing of the pump, or individual valve assembly parts are available (refer to Parts List).** |
| 15 | Complete valve assemblies can be replaced or just the individual damaged parts. To check the parts of the disc valve, remove the snap ring with a pair of snap ring pliers. |
| 16 | Once the snap ring has been removed, the valve parts may be easily removed and inspected for damage. |
| 17 | Check that all surfaces on the valve are free from nicks, burrs and dirt and are dry. Replace any necessary parts. Replace valves and valve seats together. Do not assemble an old valve on a new seat or a new valve on an old seat. |
| | **NOTE: If all valves show wear, replace all valve assemblies to prevent down time during critical periods.** |
| 18 | Reassemble the valve parts in the order shown in the illustrations, making sure the disc on the disc and spring assembly is positioned level in the seat. |
| 19 | Check that the spring and disc assembly work freely in the valve. |

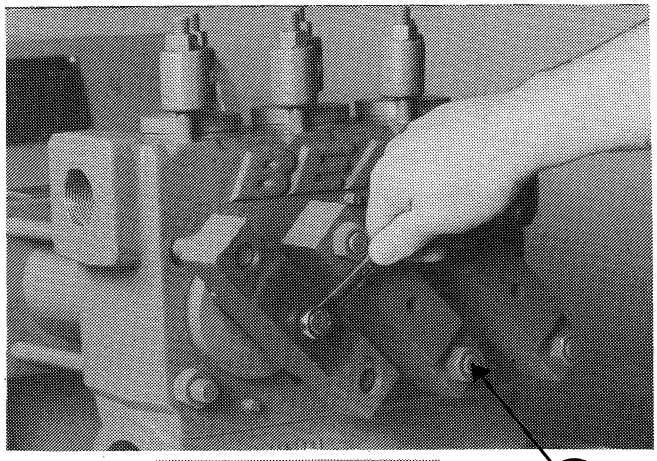
| STEPS | PROCEDURES |
|---|---|
| | **NOTE: Valve seats and bores must be clean and dry when the valves are installed.** |
| 20 | Insert suction valves squarely in the suction valve openings through the cylinder cover openings [1]. |
| | **WARNING** |
| | **Incorrectly installed valves could result in severe damage to the pump and/or injury to personnel.** |
| 21 | Use a dowel approximately the diameter of the valve and drive the valve firmly in the valve chamber. |
| 22 | Insert discharge valves through the valve cover opening so the snap ring is toward the outside of inlet openings [2]. |
| 23 | Drive the discharge valves firmly in place as in Step 21. |
| 24 | Inspect the o-rings on the valve cover. If damaged, replace. Carefully replace valve covers, taking care not to damage o-rings [3]. |
| 25 | Replace valve cover clamps. |
| 26 | Replace six (6) nuts and torque as specified. |

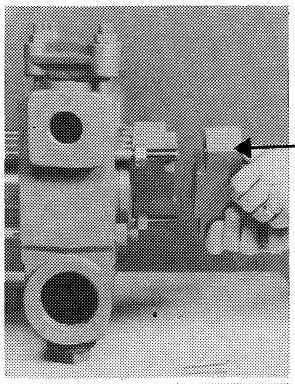


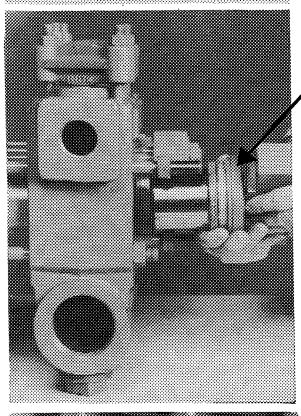
Disc Valve

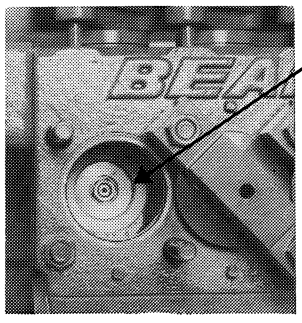






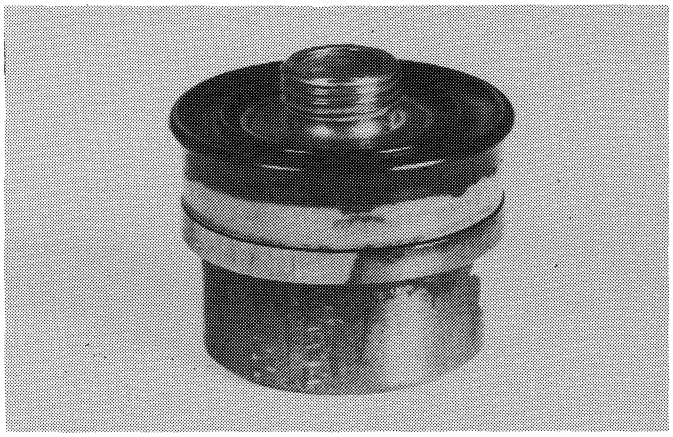



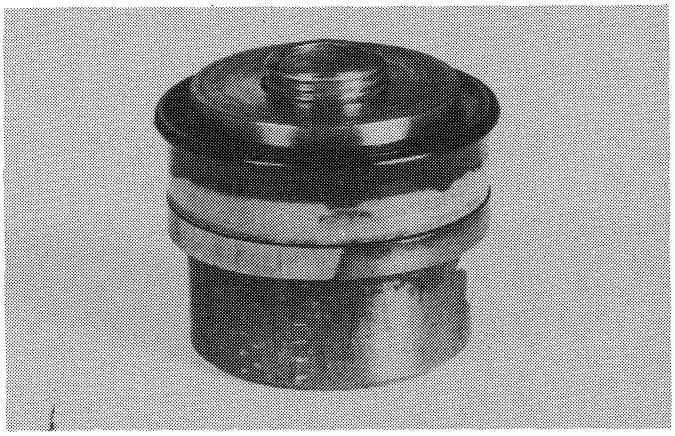

## Replacing the Piston Seals

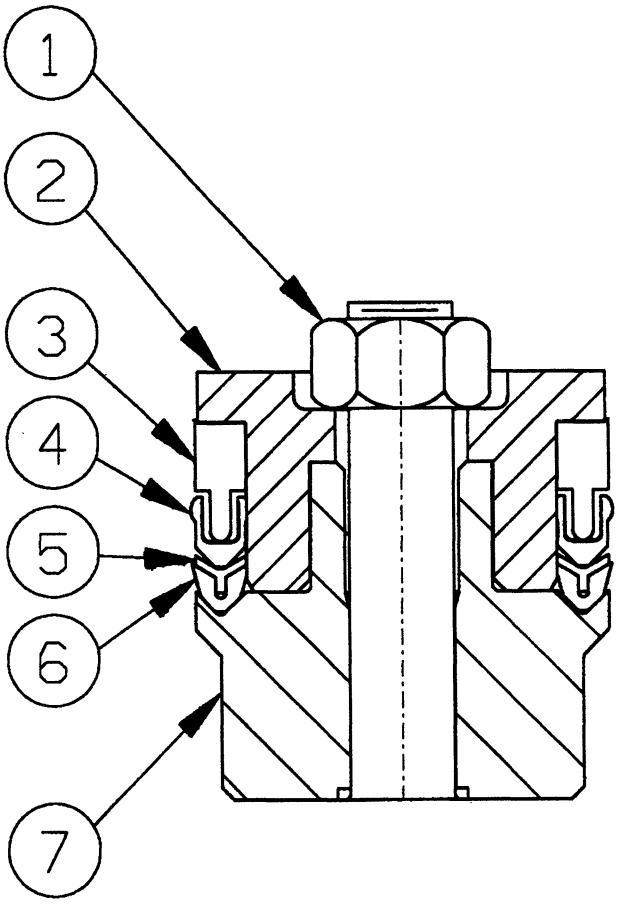
Piston seals must be replaced whenever the leakage around the seals affects the pump's efficiency. A small amount of leakage past the seals is normal and is actually desirable to help cool and lubricate the seals. However, leakage of fifteen to twenty (15-20) drops per minute indicates worn or damaged seals. To change, follow the steps listed below:

| STEPS | PROCEDURES |
|---|---|
| | **WARNING**<br>**Always disconnect the pump from the power source before performing any service to the pump. Failure to do so could result in electrical shock or injury from moving pump parts or drive parts.** |
| 1 | Check the corner nuts on the fluid cylinder to assure that they are torqued properly as specified. |
| 2 | Remove the six (6) hex nuts [1] on the front of the fluid cylinder. |
| 3 | Slide the three (3) cylinder cover clamps [2] off the fluid cylinder studs. |
| 4 | Replace the nuts on the studs. Place bar clamps on the studs. Insert a 3/8-16UNC all-thread with nut through a clamp and into a cylinder cover. Tighten the nut, pulling the cover from the valve housing. |
| 5 | Inspect o-rings [3] on the cylinder covers. If damaged, replace. |
| 6 | Insert a socket wrench into the fluid cylinder onto the hex nut [4] in the seal assembly to remove nut. |

| | |
|---|---|
| 7 | Insert the piston removal tool (FMC P/N A5049). While rotating the tool to the right, pull the piston assembly from the cylinder and out through the valve chamber. |
| 8 | Place the seal holder in a vise. Rotate the nut to the left using the FMC piston tool or a bar. |
| 9 | Remove the old seal from the seal holder and replace with new seal. Grease the back of the seal to help it conform to the seal holder. Reinsert seal washer and seal nut into seal holder and reassemble seal nut. |
| 10 | Inspect the o-ring on the end of the piston rod and replace, if necessary. |
| 11 | Pump should be rotated by hand to bring the crosshead to the front of the cylinder before installing the piston. This will reduce the distance the seal must be driven into the cylinder and minimize the chance of damage or misalignment. |
| 12 | Piston assembly can now be installed with one or two sharp raps against the tool with a 24 oz. or heavier hammer. If installation is not accomplished by two or three blows, lubrication is necessary. |
| 13 | Replace hex nut on piston rod with a socket hand wrench and torque as specified. |
| 14 | Replace the cylinder covers and cylinder cover clamps. |
| 15 | Place hex head nuts in the sequence shown and torque as specified. |








**UV Seals**

Some pumps are equipped with UV seals, a proprietary FMC design. UV seals are designed to give improved life for pumping of clean fluids. The UV seal will handle a small amount of solids incidental to common water sources. The UV seal is sold as a set. The rings are not available separately. Follow the steps listed below for the removal and installation of UV seals. The UV seal is not removed with the special FMC tool. Use a shouldered 5/8-11UNC bolt long enough to reach inside the fluid end of the piston assembly.

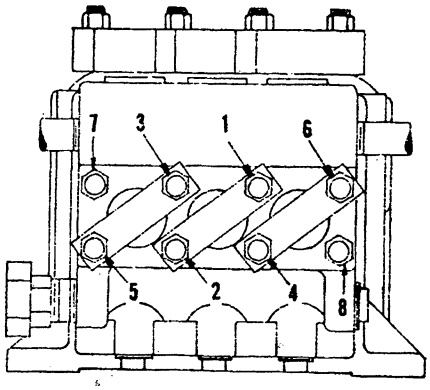
| STEPS | PROCEDURES |
|---|---|
| 1 | In order to remove the UV seal, remove the piston retaining nut [1]. |
| 2 | Rotate the pinion until the piston rod is retracted out of the piston. |
| 3 | Screw the removal bolt into the piston. |
| 4 | Pull the piston out of the cylinder bore. |
| 5 | Repeat steps 1-4 for the other two piston seals. |
| 6 | To install a new UV seal, place the UV seal rings over the seal retainer [2] in the following order:<br>a. T-adapter Ring [3]<br>b. U-ring [4]<br>c. Backup Ring [5]<br>d. V-ring [6] |
| 7 | Place the seal retainer with UV packing over the seal holder [7]. |
| 8 | Gently tap the assembly to ensure that the packing rings are well seated. |
| 9 | Screw a shouldered 5/8-11UNC bolt into the seal holder. The bolt should be long enough to reach into the fluid end cylinder from the front of the pump. |
| 10 | Place a new o-ring over the piston rod. |
| 11 | Lubricate the seal assembly and insert into the cylinder bore by hand. Remove the installation bolt. |
| 12 | Rotate the pinion until the piston rod is inserted through the seal assembly. |
| 13 | Install the retaining nut [1] and torque as specified. |
| 14 | Repeat steps 6-13 for the other two piston seals. |

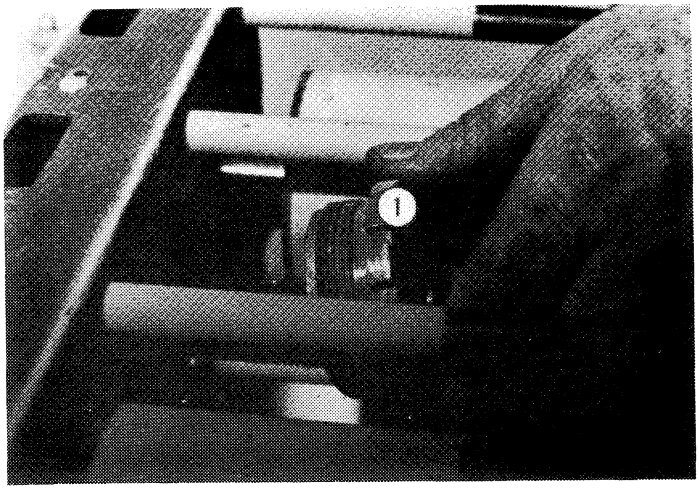
## Servicing the Cylinders

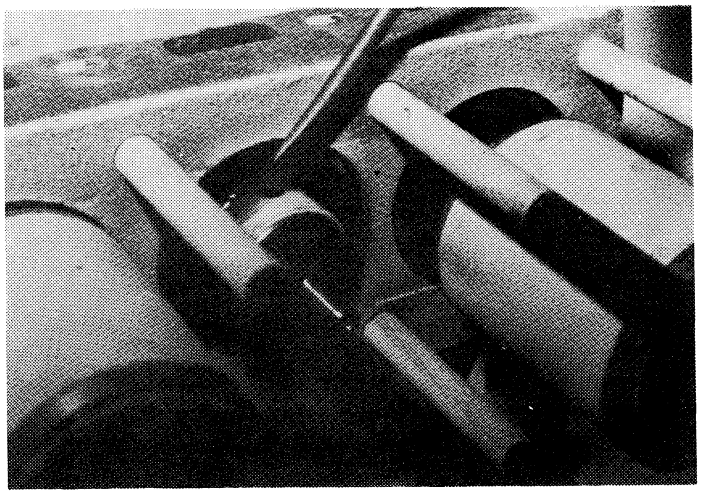
Excessive wear of seals may be due to buildup inside ceramic cylinders. Ceramic cylinders may be removed and cleaned. To clean cylinders, follow the steps listed below. It is virtually impossible to wear out a ceramic cylinder under normal service conditions, however, they are quite brittle like all ceramic materials and can be cracked or chipped if subject to mechanical impacts or severe thermal shock. Caution should be used when changing from hot to very cold fluids via fast acting solenoid valves. In the event the cylinder is cracked, broken or needs cleaning, the cylinder can be easily changed or cleaned by the following steps.

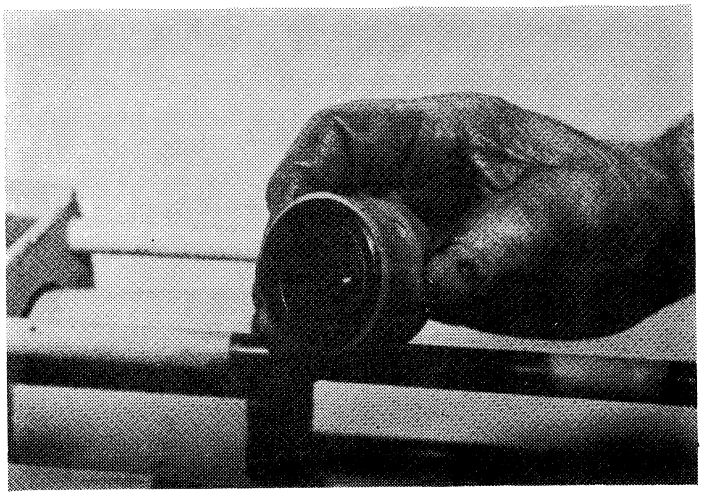
| STEPS | PROCEDURES |
|---|---|
| | **WARNING** |
| |  **Always disconnect the pump from the power source before performing any service to the pump. Failure to do so could result in electrical shock or injury from moving pump or drive parts.** |
| 1 | Disconnect the suction and discharge piping from the fluid cylinder. |
| 2 | Remove the two (2) corner hold-down nuts and slide the fluid cylinder off the studs. |
| | **NOTE: Leave the seals in place to retain the ceramic cylinders while the fluid cylinder is being removed.** |
| 3 | Remove the piston rod nuts and remove the cylinders. The piston assembly can then be pushed out of the cylinder. |
| 4 | To clean build up from cylinders, submerge the cylinder in uncut muriatic acid (28% hydrochloric acid) for three (3) minutes. Rinse in clear water and wash with a strong soap. Submerge the cylinder in the acid for two (2) more minutes and rinse in clear water and wipe off. |
| | **NOTE: Check oil seals at this point, once cylinders are removed and, if necessary, replace. To replace, follow procedures listed under Servicing the Piston Rod Oil Seals.** |
| | **CAUTION** |
| | **When removing the fluid cylinder and removing the cylinders, be careful to avoid striking the cylinders against a sharp object as they will chip or crack.** |
| 5 | Replace gaskets on each end of the cylinder. |
| 6 | Install the fluid cylinder cover and tighten the two (2) corner nuts to 1/2 the specified torque. |
| 7 | Follow Steps 6-14 for replacing piston seals (refer to page D-3). |
| | **CAUTION** |
| | **Take care when repositioning fluid cylinder and tightening nuts not to put cylinders in a bind or bump with a sharp object; damage could occur to ceramic cylinders.** |
| 8 | Replace the cylinder covers, cylinder clamps and clamp nuts; tighten nuts until they are tight. Tighten nuts to 1/2 of the full specified torque in the sequence indicated in the illustration. Repeat tightening sequence, bringing to full specified torque. This should include the two (2) corner nuts. |
| 9 | After one (1) or two (2) hours of pump operation, check torque on the clamp nuts and, if necessary, tighten. |

**TIGHTENING SEQUENCE**







## Servicing the Piston Rod Oil Seals

These seats retain oil in the pump case and prevent dirt and fluids from entering the case by way of the piston rods. Oil leakage around the piston, dirt on the case, or milky colored oil are signs of worn or damaged crosshead seals. The seals may be replaced without disassembly of the drive end, however, the fluid end must be disassembled. To change the seals, follow the steps below.

| STEPS | PROCEDURES |
|---|---|
| | **WARNING** |
| | **Always disconnect the pump from the power source before performing any service to the pump. Failure to do so could result in electrical shock or injury from moving pump parts or drive parts.** |
| 1 | Break down the fluid end of the pump following the steps listed under Servicing the Cylinders. |
| 2 | Once fluid cylinder and cylinder seals have been removed, remove the cover at the pump separation chamber by removing the two (2) screws. |
| 3 | Insert a large screwdriver into the opening under the separation cover. Using the screwdriver, rotate the oil seal nut to the left until it is unthreaded from the pump case [1]. |
| 4 | Remove the oil seal sleeve and oil seals from each piston rod opening. Slide the sleeve and oil seals from the piston rod using a simple hook-shaped tool. |
| | **NOTE: It is never advisable to reuse oil seals which have been removed from the pump.** |
| 5 | Replace the outer seal so that the lip on the seal faces the fluid cylinder. Position seal into sleeve until it bottoms out. Replace inner seal so the lip faces the power end of the pump. |
| 6 | Pack the area between the seals inside the sleeve with a water-resistant grease before installing them in the pump. |

| STEPS | PROCEDURES |
|---|---|
| 7 | Position a piece of thin-walled tubing, ground to a thin edge, or thin shim stock or piece of heavy paper rolled in a tube inside the seal. This will protect the lips on the seal while passing them over the piston rods. Now slide the sleeve and seals with the protection piece of tubing or paper over the rod and into the case.<br><br>**CAUTION**<br>**Care must be taken to avoid folding the lip under when the seals are passed over the end of the piston rods. Failure to do so could damage seals, resulting in leakage around seals.** |
| 8 | Once sleeve and oil seals are in place on piston, replace oil seal nut and tighten. **(Do not over-tighten as it will damage the Delrin* washer.)** |
| 9 | Replace the fluid end parts by repeating steps found in Servicing the Cylinders. |

* Delrin is a registered trademark of E. I. DuPont.

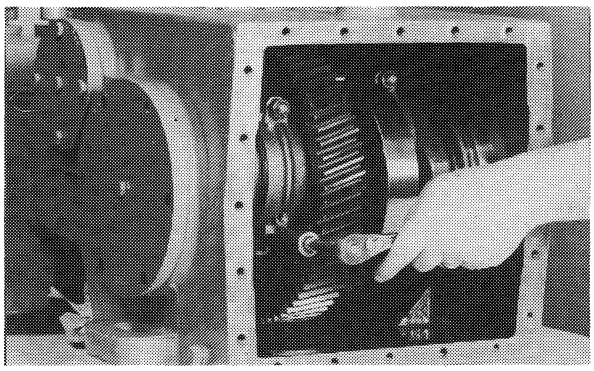
## Servicing the Power End

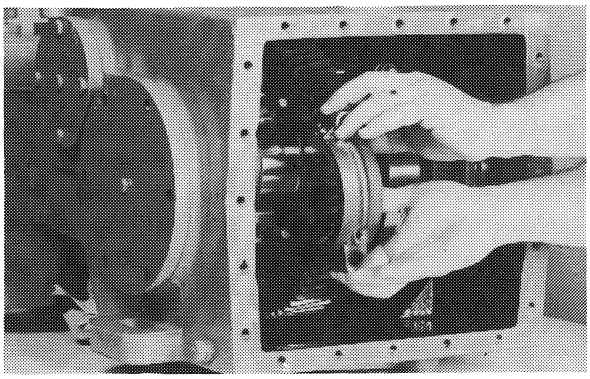
### Servicing the Crankshaft and Connecting Rods

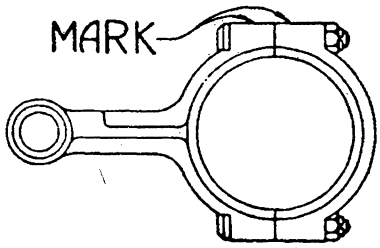
These components seldom need servicing or replacing unless the pump has been run without oil or with severely contaminated oil. Problems with the shaft and rods will be indicated by a knocking noise or excessive pump case temperature.

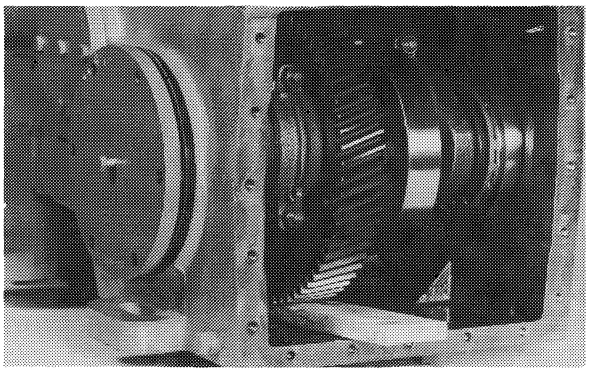
| STEPS | PROCEDURES |
|---|---|
| | **WARNING** |
| |  **Always disconnect pump from power source before performing any service to the pump. Failure to do so could result in electrical shock or injury from moving pump or power end parts.** |
| 1 | Disconnect piping to valve chamber. |
| 2 | If possible, remove the pump from its mounting and place on a bench or other convenient place for servicing the power end. |
| 3 | Place container under the drain plug in the power end and remove the drain plugs; drain all oil. |
| 4 | Remove the eight (8) nuts on the fluid cylinder studs. |
| 5 | Slide the three (3) cover clamps off the studs. |
| 6 | Remove the fluid cylinder from the pump. |
| | **NOTE: To prevent unnecessary down time, valves, seals and other wear areas should be changed while breaking down the pump.** |
| 7 | The piston seals must now be removed. Follow Step 3, page D-6. |
| 8 | Loosen the oil seal nut (Step 3, page D-7). |
| 9 | Remove the oil seal sleeve and oil seal (Step 4, page D-7). |
| 10 | Remove the capscrews, washers, cover and gasket from the power end of the pump. |

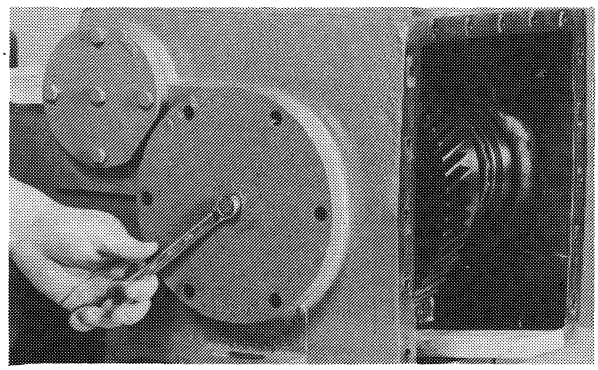
| | |
|---|---|
| 11 | Remove the four (4) capscrews from the pinion bearing covers at each side of the pump case. |
| 12 | Remove the blind side pinion bearing housing by inserting a long 3/8-16UNC screw in the middle of the housing. Then remove the other pinion bearing housing by inserting long 1/4-20UNC screws in the flange of the housing surrounding the input shaft. |
| 13 | Remove the shaft from the pump, then use a press and suitable blocks to press the bearings from the shaft. |
| 14 | Remove the self locking nuts, connecting rod caps, cap bolts, and bearing from each connecting rod assembly and check for matching marks as suggested in illustration. Rods and caps may already be marked; if not, do so.<br><br>**CAUTION**<br><br>**Be sure to match and mark each cap and connecting rod for matching when reassembling the pump. Failure to do so could cause damage to connecting rods.** |
| 15 | Remove the 3/8" 16 UNC capscrews from the center of the crankshaft bearing housing. |
| 16 | Place wooden block supports under the crankshaft and gear assembly to avoid possible damage by dropping when bearing cups are removed. |
| 17 | Remove the six (6) capscrews which hold the crankshaft bearing housing at each side of the pump case. |
| 18 | Insert a 3/8" 16 UNC tap bolt approximately 4" long into the hole at the center of each housing and turn the screw as suggested in illustration to remove the housing from the pump. |

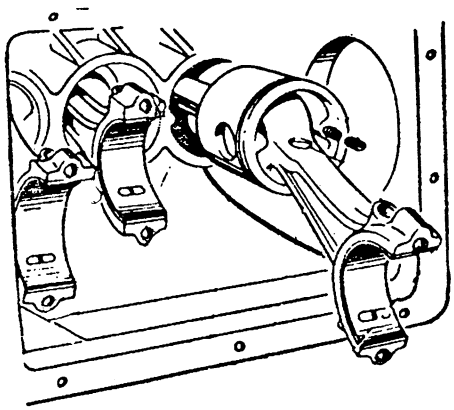










| | |
|---|---|
| 19 | In order to remove the crankshaft from the power end, push all connecting rods as far as possible into the crosshead bores. Locate the throw that is farthest from the gear and rotate the crankshaft so that the throw is straight up. Pull the end of the crankshaft nearest the gear from its bore. As the crankshaft clears the connecting rod, rotate the crankshaft as needed to clear the case. |
| 20 | Pull connecting rods and crosshead assemblies from case, taking care to place parts so they will be reassembled in the same bore from which they were removed.<br><br>**CAUTION**<br><br>**Be sure to match and mark each cap and connecting rod for matching when reassembling the pump. Failure to do so could cause damage to connecting rods.** |
| 21 | Remove the two (2) set screws used to lock each crosshead pin in the crosshead assembly and remove crosshead pin. |
| 22 | Press busings out and replace with new bushings, if necessary. Ream the bushings to 1.2505 in. +.001/-.000. |
| 23 | Using automotive type puller, remove the bearing cones from the crankshaft. |
| 24 | Inspect the crankshaft bearings for (a) cleanliness, (b) rust spots when rotated, (c) visible wear or damage, or (d) damage/slack between the inner and outer races of the bearing. |

**NOTE: All damaged bearings must be replaced with new bearings. If one (1) bearing is faulty, it is a good practice to replace both bearings even though no damage is visible on the other bearing.**

| | |
|---|---|
| 25 | Inspect the crankshaft for damage; excessive scoring or pitting on the crankshaft indicates need for replacement. |

| | |
|---|---|
| 26 | Inspect the connecting rods for damage; excessive scoring or pitting on the connecting rods indicates need for replacement. |
| 27 | Inspect the crosshead assemblies and replace if any wear is visible. |
| 28 | Clean all parts in a solvent and apply a thin coat of oil (grade SAE 80W90) before installing. |
| 29 | Thoroughly clean casing cap in solvent and blow dry. |
| 30 | Press new bearing in place. |

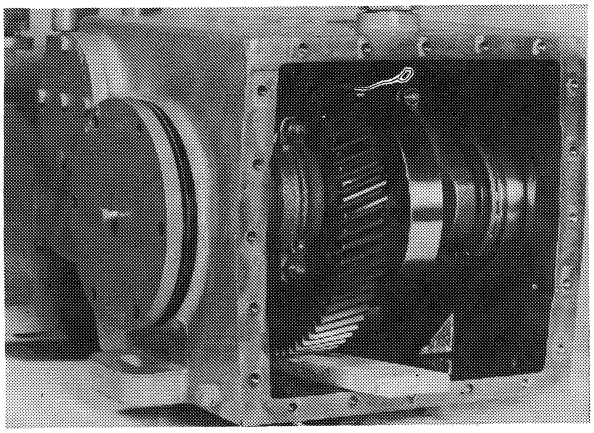
**CAUTION**

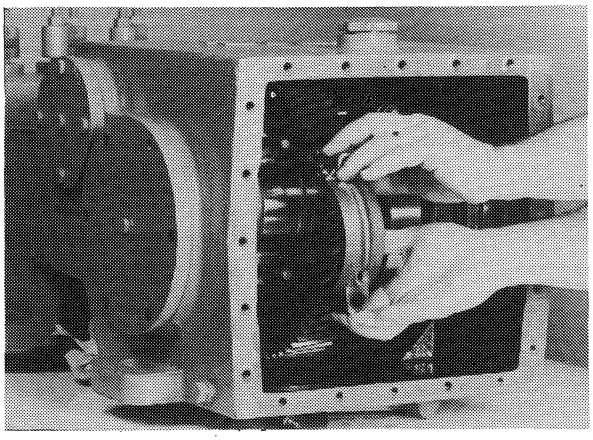
**Use extreme care when installing bearings. They can be easily damaged, shortening their life and efficiency.**

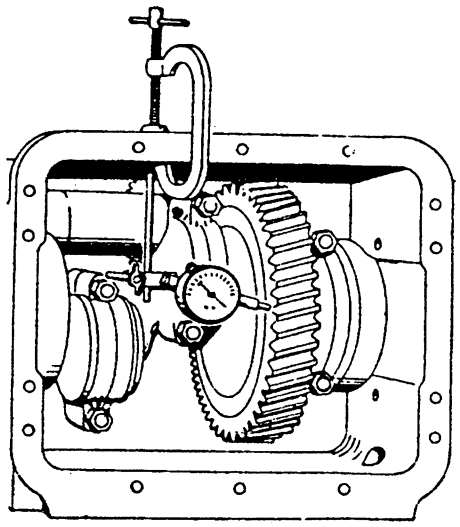
| | |
|---|---|
| 31 | Reassemble the crosshead assemblies and connecting rods. Be sure to return both set screws to each hole to lock the pins in place with the inner screw seated in the indention on the outer face of the pin. |
| 32 | Replace connecting rods in their original openings from which they were assembled. Be sure connecting rod oil pockets are in the up position. |
| 33 | Install crankshaft, reversing procedure in Step 19. |
| 34 | Replace gaskets on crankshaft bearing housings. |
| 35 | Replace the crankshaft bearing housings with their original shims and tighten capscrews. |
| 36 | Replace connecting rod caps with original connecting rods. Leave loose until crankshaft end play is adjusted. |

**CAUTION**

**Be sure to match each cap and connecting rod as they were originally assembled. Failure to do so could cause premature wear in connecting rods or shaft.**







| | |
|---|---|
| 37 | Proper end play adjustment in the assembled crankshaft and bearings is required to avoid excessive bearing wear. The crankshaft should have between .002 tight and .003 free endwise movement. Before checking end play, the connecting rods should be loosened to allow free movement to the crankshaft. |
| 38 | Move the crankshaft fully to one end and place dial indicator against the face of the gear as shown in the illustration. |
| 39 | Set the dial indicator at zero and move the crankshaft indicating its total endwise movement. |

**NOTE: The force required to move the crankshaft should be only enough to insure total endwise movement but not enough to spring the sides of the pump case.**

| | |
|---|---|
| 40 | If endplay is not between .002 tight and .003 free, remove crankshaft bearing housings and adjust shim. Shim should be equally distributed between the two ends of the shaft. |
| 41 | Install pinion shaft. As with the assembled crankshaft, the assembled pinion shaft and bearings require the proper end play adjustment. The same basic steps for adjusting the end play of the crankshaft should be followed to adjust the end play of the pinion shaft with the exception that the dial indicator should be placed against the end of the input shaft. |
| 42 | Replace the pinion bearing housing. Center the oil seal carefully around the shaft before final tightening of the capscrews. |
| 43 | Replace the magnetic drain plugs in the side of the pump case. |
| 44 | Torque connecting rod nuts as specified. |
| 45 | Replace the capscrews, cover and gaskets from the power end of the pump. |
| 46 | Refill the case with ten (10) quarts of clean high grade SAE 80W90 weight gear oil. |
| 47 | Turn the pump a few revolutions by hand to be sure that all parts are properly installed and adjusted before returning the pump to its mounting. |
| 48 | Replace fluid end of the pump as described under Servicing the Cylinders. |

### Servicing the Bearings

A knocking sound around the bearing or excessive heat coming from the pump case adjacent to the bearing are indications of faulty bearings. To inspect the end bearings (tapered roller), the bearing housings and back cover must be removed. If replacement of the end bearings is required, the crankshaft should be removed. The rod inserts can be inspected and/or replaced by removing the back cover and rod caps. (Refer to Servicing the Power End.)

### Reading the Troubleshooting Chart

The following chart is designed to help you easily define and correct problem areas. As you can see, the chart is divided into two (2) columns. The first item is the Symptom; this is the signal that something is wrong. Once you have noticed the symptom, you must determine the Cause; one symptom may be the signal for any one of various problems. The column titled Test and Result will be your aid for determining the Cause and Remedy.

**Troubleshooting Chart**

**Symptom**
**Discharge Pressure Too Low**

| Test/Result | Cause/Remedy |
|---|---|
| Connect a hose to the overflow port in the relief valve and start the pump.<br><br>1. Close all guns and/or nozzles and check overflow.<br><br>RESULT: No overflow, see Item 1, then recheck pressure.<br><br>RESULT: Flow through overflow hose, see Item 2, then recheck pressure.<br><br>2. Open all of the discharge guns or nozzles.<br><br>RESULT: No flow in the overflow hose, see Items 3 and 4, recheck pressure.<br><br>RESULT: Flow through the overflow hose, see Items 5 and 6, or 7, recheck pressure. | 1. Restriction in suction line.<br><br>Check for clogged strainers, closed valves, emptied suction tank.<br><br>2. Incorrect relief valve adjustment.<br><br>To increase the relief pressure, tighten the nut on top of the valve by turning clockwise (refer to page B-3).<br><br>**WARNING**<br><br>**Do not exceed the rated pressure of the pump.**<br><br>3 Incorrect nozzle size.<br><br>Worn nozzles or nozzles with capacity in excess of the pump capacity will reduce the discharge pressure - replace where required. Refer to nozzle manufacturer's literature.<br><br>4 Pump speed too low.<br><br>Change the sheave combination to obtain the desired speed.<br><br>**CAUTION**<br><br>**Do not exceed the maximum rated speed.**<br><br>5 Worn seat or stem in the relief valve.<br><br>Replace parts as required.<br><br>6 Worn packing cup in the relief valve.<br><br>Replace the packing if water is leaking through the openings in the relief valve body.<br><br>7 Foreign material lodged in the relief valve.<br><br>Relieve the spring tension and flush the interior of the valve to remove foreign material. |

**Symptom**

**Discharge Flow Too Low - low flow will be caused by slow pump speed or low volumetric efficiency.**

| Test/Result | Cause/Remedy |
|---|---|
| 1. Calculate displacement gallonage of the pump as follows:<br>a. Measure pinion shaft speed with a tachometer.<br>b. Multiply speed by gallons per revolution as shown on specification sheet (assuming 100% V.E.).<br>RESULT: Flow lower that required, see Item 1.<br>RESULT: Flow equal to or larger than required, see Test 2.<br>2. Volumetric efficiency is a measure of how much the actual output is less than the displacement. To determine volumetric efficiency:<br>a. Measure the actual flow from the pump.<br>NOTE: One gal. of water weighs 8.33 lbs. and fills .1337 cu. ft.<br>NOTE: Measured flow is actual gallon per minute (GPM) output.<br>b. Divide the actual GPM found in Step a. by the displacement GPM found earlier, then multiply by 100 to get the volumetric efficiency.<br>$\text{Vol. Eff. I} = \frac{\text{Actual GPM}}{\text{Displ. GPM}} \times 100$<br>Normal Volumetric Efficiency - 85-90%<br>RESULT: Normal volumetric efficiency but gallonage less than required, see item 1.<br>RESULT: Volumetric efficiency less than normal, see Items 2, 3 and 4 or Cavitation. | 1. Pump speed too slow.<br>Change the sheave combination to obtain desired speed. (Refer to Specification Manual and Installation Procedures, page A-1.)<br>**CAUTION**<br>**Do not exceed maximum rated speed.**<br>2. Leakage from the pump piston seals.<br>Leakage exceeding 15-20 drops per minute indicates that the seals should be replaced (refer to page D-3).<br>3. Suction or discharge valve seats worn, pitted or broken.<br>Inspect and replace where necessary (refer to page D-1).<br>4. Restriction in the suction line.<br>Check for clogged strainers, closed valves, or emptied suction tank. |

**Symptom**

**Cavitation - Cavitation in the pump occurs when the cylinders do not completely fill with water during the suction stroke. Resultant pressure pulsations can severely damage the pump and related piping if the condition is not recognized and corrected immediately.**

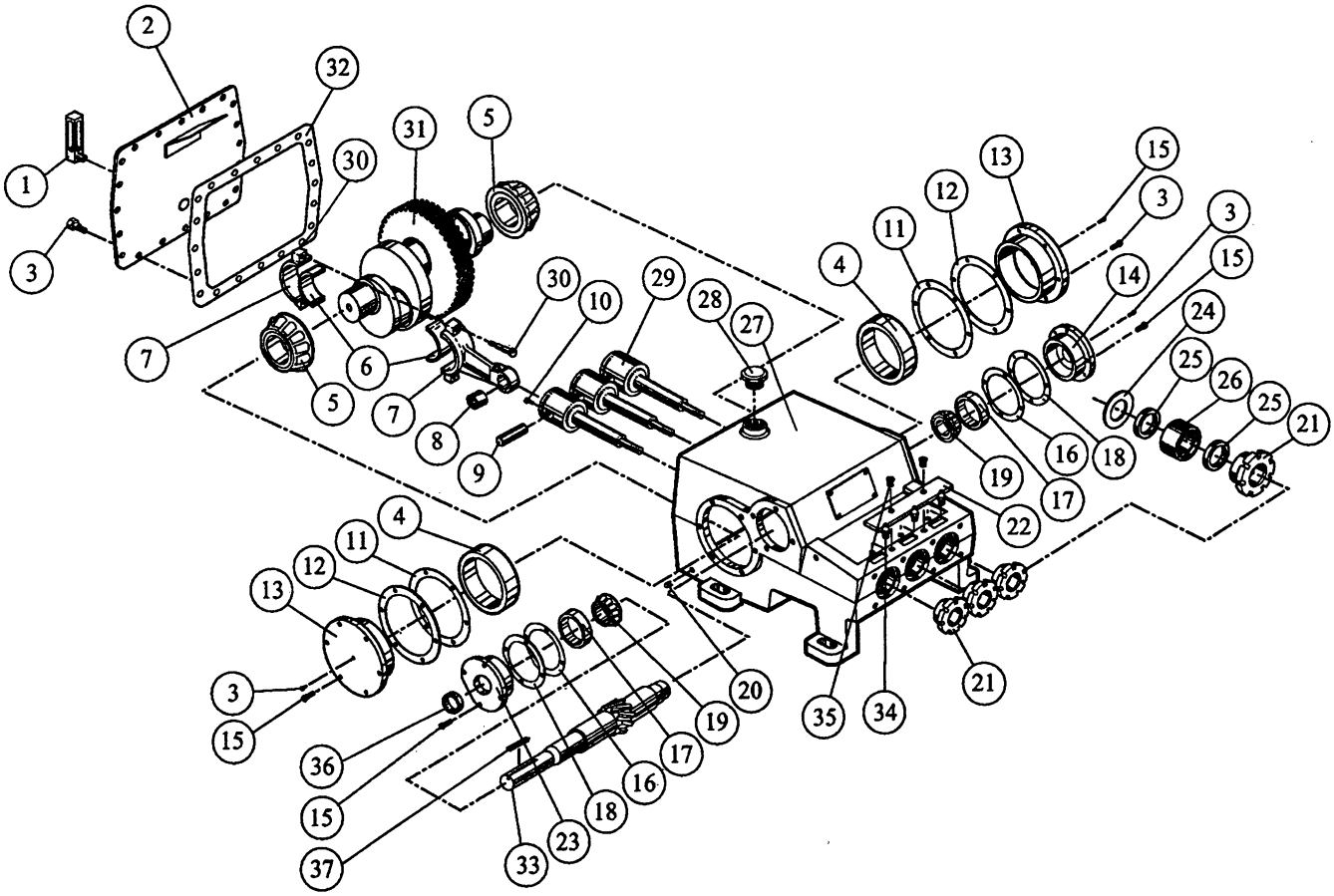
| Test/Result | Cause/Remedy |
|---|---|
| Check the following to determine if cavitation exists:<br>1. Volumetric Efficiency<br>$\text{Vol. Eff. I} = \frac{\text{Actual GPM}}{\text{Displ. GPM}} \times 100$<br>(Refer to Specification Manual)<br>RESULT: Less than normal vol. eff. with good valves and piston seals indicates cavitation.<br>2. Discharge pressure<br>RESULT: Less than expected and fluctuating erratically indicates cavitation.<br>3. Pulsations in suction or discharge line.<br>RESULT: Erratic pulsations of abnormal magnitude indicate cavitation.<br>4. Listen for sharp erratic hammering sounds in the valve chamber.<br>Do not confuse the sharp regular sounds of the valves with the erratic sound that indicates cavitation.<br>NOTE: There are several causes of cavitation. Once the problem has been determined as cavitation from the above test, the following test must be performed to determine the cause.<br>a. Reduce the temperature of the pump liquid to room temperature.<br>RESULT: If cavitation stops, see Item 1. | 1. Vapor pressure too high at pumping temperature.<br>Reduce the temperature or increase the suction pressure by an amount sufficient to overcome the vapor pressure (refer to Section A, Installation Procedures).<br>2. Turbulence in the pump suction inlet.<br>Relocate overflow lines further from the pump inlet. If necessary, provide a tank to supply undistributed suction flow conditions to the pump.<br>3. Suction or discharge valves' seats worn, pitted or broken.<br>Inspect and replace, where necessary (refer to page D-1).<br>4. Excessive losses in the suction piping.<br>Increase the suction pipe diameter, increase the suction pressure or reduce the length of the suction line. In some cases, an air chamber may be required to sufficiently reduce the suction losses (refer to Installation Procedures, page A-2).<br>5. Air leaking into the suction system.<br>Inspect and tighten all the hose and pipe connections.<br>6. Water hammer in the discharge line.<br>Install an air chamber or an accumulator in the discharge piping (refer to Installation Procedures, page A-4).<br>7. Weak and partially worn piston seals.<br>Partially worn piston seals may draw air on suction stroke but not leak on the discharge stroke. This will cause the pump to operate as if cavitating. Replace the seals (refer to Service, page D-3). |

| Test/Result | |
|---|---|
| b. If the relief valve overflow is piped into the pump suction line, disconnect the overflow line.<br>RESULT: If cavitation stops, see Item 2.<br><br>c. Disconnect the suction inlet piping and replace it with a short hose connected to a barrel or tank.<br>RESULT: If cavitation stops, see Items 3,4 and 5.<br><br>d. Disconnect the discharge piping and connect a short hose to the pump outlet.<br>RESULT: If cavitation stops, see Item 6.<br><br>e. Replace the pump piston seal and inspect the valve assemblies.<br>RESULT: If cavitation stops, see Item 7. | |

**Symptom**

**Noise coming from bearings and crankcase area.**

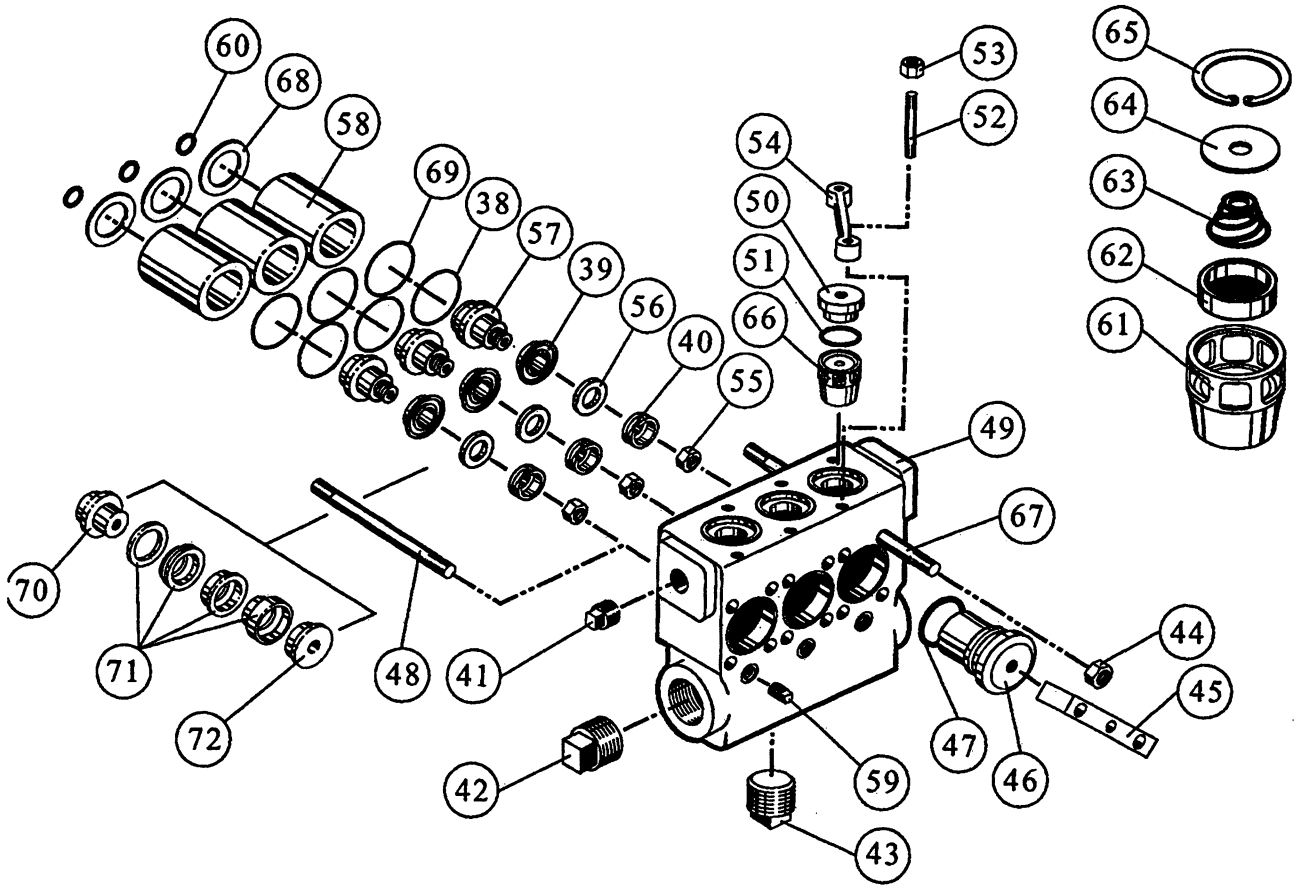
| Test/Result | Cause/Remedy |
|---|---|
| See Item 1. | 1. Worn or damaged bearings.<br>Change bearings (refer to Servicing the Power End, page D-9). |



# Parts List - L16 Pump - Power End

| Item | Description | Qty. | Item | Description | Qty. |
|---|---|---|---|---|---|
| 1 | Sightglass | 1 | 19 | Bearing Cone - Pinion | 2 |
| 2 | Back Cover | 1 | 20 | Pipe Plug - Magnetic - 1/2 | 4 |
| 3 | Hex Head Cap Screw - 3/8 - 16UNC x 3/4 | 23 | 21 | Packing Nut | 3 |
| 4 | Bearing Cup - Crankshaft | 2 | 22 | Inspection Plate | 1 |
| 5 | Bearing Cone - Crankshaft | 2 | 23 | Pinion Bearing Housing w/hole | 1 |
| 6 | Bearing Insert | 6 | 24 | Packing Washer | 3 |
| 7 | Connecting Rod | 3 | 25 | Oil Seal | 6 |
| 8 | Bushing (included with connecting rod) | 3 | 26 | Sleeve - Packing Nut | 3 |
| 9 | Wrist Pin | 3 | 27 | Power Frame | 1 |
| 10 | Set Screw - 5/16-18UNC x 5/16 | 6 | 28 | Oil Cap | 1 |
| 11 | Gasket - Crankshaft Housing | 2 | 29 | Crosshead & Piston Rod Assembly | 3 |
| 12 | Shim - Crankshaft Housing | As Req'd | 30 | Connecting rod bolt & nut (included with connecting rod) | 6 |
| 13 | Bearing Housing - Crankshaft | 2 | 31 | Crankshaft & Gear Assembly | 1 |
| 14 | Pinion Bearing Housing w/o hole | 1 | 32 | Gasket - Back Cover | 1 |
| 15 | Hex Head Cap Screw - 3/8 - 16UNC x 1-1/4 | 20 | 33 | Pinion Shaft | 1 |
| 16 | Gasket - Pinion Housing | 2 | 34 | Lube Fitting - 1/8 | 3 |
| 17 | Bearing Cup -Pinion | 2 | 35 | Hex Head Cap Screw - 1/4 - 20UNC x 1/2 | 2 |
| 18 | Shim - Pinion Housing | As Req'd | 36 | Oil Seal | 1 |
| | | | 37 | Key - 3/8 sq. x 2-1/2 | 1 |

* For part numbers, reference Specifications Manual.




# Parts List - L16 Pump - Fluid End

| Item | Description | Qty. | Item | Description | Qty. |
|---|---|---|---|---|---|
| 38 | Cylinder Seal Ring | 3 | 58 | Piston Cylinder | 3 |
| 39 | Bulletnose Piston Seal | 3 | 59 | Pipe Plug - 1/8 | 4 |
| 40 | Bulletnose Piston Nut | 3 | 60 | O-ring - 5/8 | 3 |
| 41 | Pipe Plug - 1-1/4 | As Req'd | 61 | Valve Seat (included in valve assembly) | 6 |
| 42 | Pipe Plug - 2-1/2 | As Req'd | 62 | Valve Disc (included in valve assembly) | 6 |
| 43 | Pipe Plug - 2 | As Req'd | 63 | Valve Spring (included in valve assembly) | 6 |
| 44 | Nut - 5/8-11UNC | 8 | 64 | Valve Washer (included in valve assembly) | 6 |
| 45 | Cylinder Cover Clamp | 3 | 65 | Retaining Ring (included in valve assembly) | 6 |
| 46 | Cylinder Cover | 3 | 66 | Valve Assembly | 6 |
| 47 | O-ring - 3-1/8 | 3 | 67 | Short attaching stud | 2 |
| 48 | Long Attaching Stud | 6 | 68 | Cylinder Gasket | 3 |
| 49 | Valve Chamber | 1 | 69 | O-ring - 3-1/4 | 3 |
| 50 | Valve Cover | 3 | | | |
| 51 | O-ring - 2-3/8 | 3 | ----Items 70, 71 and 72 are alternate seals for Items 39, 40, 56 and 57 --- | | |
| 52 | Valve Cover Stud | 6 | 70 | UV Seal Holder | 3 |
| 53 | Nut - 1/2-13UNC | 6 | 71 | UV Seal Assembly | 3 |
| 54 | Valve Cover Clamp | 3 | 72 | UV Seal Retainer | 3 |
| 55 | Nut - Brass - 1/2-13UNC | 3 | | | |
| 56 | Bulletnose Piston Seal Retainer | 3 | | | |
| 57 | Bulletnose Seal Holder | 3 | | | |

* For part numbers, reference Specifications Manual.

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